Telco TV Home Networking Technology and Market Outlook

Independent Data and Analysis by S2 Data Corporation

Introduction

Telecom operators worldwide are rapidly seizing the opportunity to challenge incumbent cable MSOs and DBS providers by delivering a suite of voice, video and data services collectively known as the "Triple-Play". By leveraging IP-based technologies, Telcos are able to offer a compelling suite of services including IPTV, Video-on-Demand, messaging, gaming, and interactive experiences. Telecommunications carriers have been deploying high-speed access networking technologies such as Fiber-to-the-Home and VDSL and are planning additional upgrades to enable more advanced services.

As many of the access network issues have been resolved, whole-home entertainment networking has risen to the forefront as one of the central issues Telcos are working to resolve. With an average of almost three TVs in each US household and over 2.4 in Europe, delivering IPTV and other IP-based services to each entertainment node in the home presents unique challenges.

Recently, several home networking technologies have emerged, each positioned by their proponents as the leading candidate to solve the whole-home networking challenge. The rapid-fire introduction of so many competing candidates offers Telcos compelling alternatives to the cumbersome and costly practice of rewiring the customer premises with Cat-5 cabling, while at the same time creating some confusion and uncertainty.

Competing for primacy in the home networking market are technologies operating over coaxial cabling, powerline, phoneline and wireless air interfaces. Aside from selecting which physical medium is most appropriate for each Telco's IPTV deployment, several other business and technical factors must be weighed carefully before operators can select the winning home networking technology.

This whitepaper will provide the reader with valuable insights on the global IPTV market opportunity and will convey the importance of deploying a winning whole-home networking solution. Each technology being proposed is weighed against a series of criterion which are employed by operators currently evaluating and deploying home networking solutions. Lastly, the paper articulates which customer premises equipment (CPE) must be enabled with networking solutions in order to deliver the complete suite of services to key entertainment hubs within the home. Detailed forecasts are presented, which provide insight into how and where operators will deploy the myriad of technologies discussed in this paper.

IPTV Subscriber Forecast

After several years of trials and small-scale deployments, IPTV is poised for significant growth. Consolidation among IPTV technology suppliers has enabled operators to deploy using fewer suppliers, effectively streamlining deployments. In addition, the underlying broadband access technologies such as FTTH and high-speed DSL variants are being aggressively deployed and cost-reduced as economies of scale are achieved. These and other factors are the driving force behind the forecast presented below.

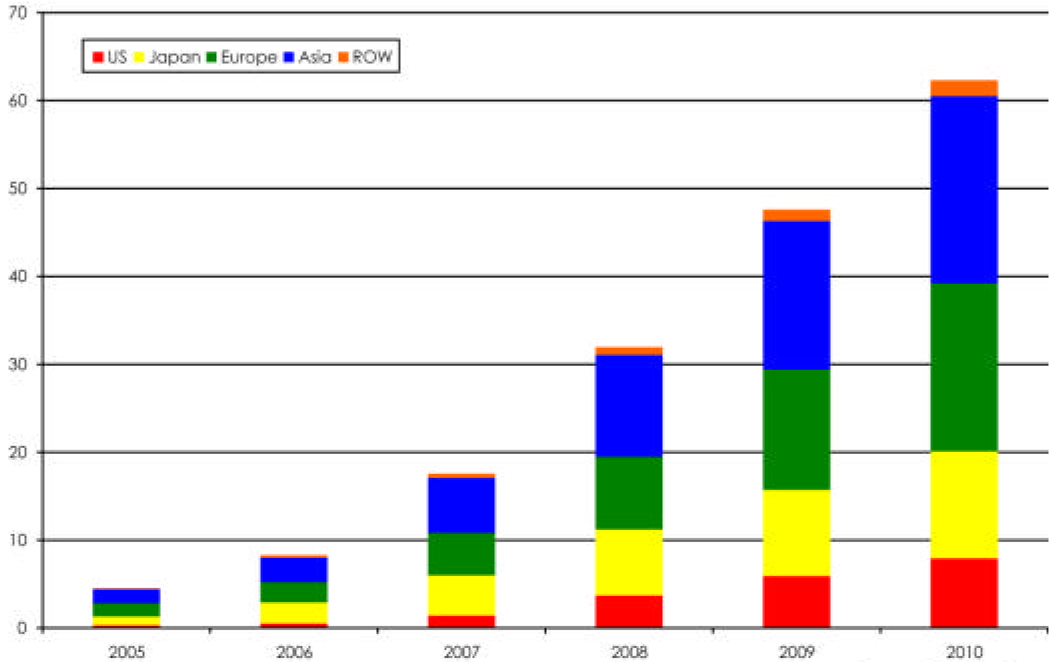
Worldwide IPTV Subscriber Forecast (millions of subs)

	2005	2006	2007	2008	2009	2010
Units	4.5	8.3	17.6	32.0	47.6	62.3

Source: S2 Data Corp.

At the end of 2005, there were 4.5 million IPTV subscribers worldwide. The majority of those subscribers were located in Europe and Asia. The market is expected to surge in 2007, with total subscribers increasing to 17.6 million. By 2010, the number of worldwide subscribers will grow to more than 62 million. The growth in this market represents a 69.1% CAGR for the forecast period.

Worldwide IPTV Subscriber Forecast (millions of cumulative subs)



Source: S2 Data Corp.

The number of deployments forecasted represents a tremendous market opportunity for CPE manufacturers, networking component suppliers and other key technology developers. However, in order to achieve the forecasted number of deployments, telecommunications operators must solve a number of key issues

Multi-Room Networking / Whole-Home DVR

One of the central challenges operators face when deploying IPTV is the distribution of IPTV streams and other IP services to multiple set top boxes within the home. While delivery of multiple standard-definition and high-definition video streams is of paramount concern, several other factors are dictating home networking bandwidth and capacity requirements. Whole-home DVR, Video-on-Demand, Voice-over-IP and other broadband data services such as messaging, gaming and peer-to-peer services put additional loads on the home network. While operators may choose a phased approach to deploying these services, they must also now plan sufficient headroom in the home network in order to overlay additional services in the future while protecting their initial investment.

Most early networking technologies were designed to provide simple data networking for broadband Internet and file sharing on a 'best-effort' basis. Whole-home entertainment networking requires a highly robust and intelligent network which can connect a diverse set of platforms such as multiple IP STBs, home/residential gateways, PCs, media servers, whole-home DVR Set Top Boxes, and other digital home devices.

From a business model perspective, operators are eager to reduce the amount of time installers are required to be in the home. IP-STBs must also be networked through a reliable backbone which will not be prone to outages, dropped frames, interference and other factors which may impact the overall quality of service. Foremost, the networking technology must be cost-effective in order to bring the per-customer equipment and deployment costs into compliance with the business model.

Operator Evaluation Criteria for Multi-room Entertainment Networking

Choosing the right home networking technology is critically important to the long-term success of IPTV deployments. Home networking technology choice is rapidly transitioning from a consumer-centric model, to one that is solely the domain of the operator. The vast number of unique Telecom operators and service providers worldwide each evaluate networking technologies within a common set of parameters. While specific requirements will differ between deployments, the following table illustrates the most common set of evaluation criteria.

Capacity / Bandwidth

Performance requirements vary between operators. Most require a minimum of 30 Mbps to deliver a basic set of services, while many are now targeting data rates greater than 200 Mbps within the home to accommodate future applications and services. It is vital that the home network bandwidth be sufficient to handle peak IPTV traffic and other IP-based traffic generated on the network by Peer-to-Peer services, VoIP, Media Servers, Video on Demand, or other devices.

Deployment Cost

Operators and Customer Premises Equipment manufacturers have widely ranging cost parameters. The hardware component cost is only one factor in determining the total deployment cost of a given technology. Other factors include the ability to integrate, cost of external adapters, access points, length of time to deploy, and potential unforeseen upgrades in wiring and cabling necessary to achieve full bandwidth.

Quality of Service

QoS generally refers to the set of parameters and specific technical implementations which mitigate packet delay, jitter, loss rates, latency and ensure the desired user experience. In the challenging IPTV environment, it is vital that home networking technologies be able to guarantee QoS in accordance with industry norms.

Ease of Installation

Ease of installation is of paramount concern to operators as lengthy installations increase labor costs and slow down the number of customers which can be serviced on a given day. Generally, a no-new-wires approach is a primary factor in achieving ease of installation. Reuse of existing infrastructure in the home minimizes the time required for technicians to be at the customer premises.

Future-Proof

As operators deploy higher bandwidth ‘last mile’ technologies such as VDSL, VDSL2+ and Fiber to the Home, operators’ home network bandwidth and capacity requirements are rapidly increasing. As operators broaden their service set to compete with Cable MSO’s and Satellite operators new services will be deployed which will place an ever increasing burden on the home network. It is reasonable to assume that current IPTV bandwidth requirements represent only the beginning in terms of the types of services the network will be expected to deliver in the future. Future-proofing the home network requires deploying network infrastructure and bandwidth capacities that are well above what is needed today in order to support emerging services in the future. This is imperative for operators to protect their investment.

Standards Compliance / Technology Licensing

Networking technologies developed in accordance with standards-body guidelines and proper licensing agreements allow a competitive market to develop between multiple companies. This provides OEMs with multiple sources for hardware and drives down costs for technology implementers as a result of increased competition. In addition, standards-based technologies generally undergo rigorous interoperability and compliance testing.

Coverage Area

Customers increasingly are requiring multiple TVs/displays in diverse locations throughout the home – bedrooms, living room, kitchen, office/den, basements, etc. Networking technologies must be able to reach the primary entertainment hubs within the home. This is generally achieved by increasing the number of available 'outlets' or connection points for a given networking technology.

Customer Installable

Providing a customer installable solution is an emerging requirement from some operators. Generally installation technicians will be required at the customer premises during the initial deployment. However, customer-installable solutions can be used to allow customers to add additional TVs or upgrade equipment after the initial installation and provisioning.

Privacy and Security

The home data and entertainment network must provide a closed and secure environment. Access to data traffic and service provider content must be limited to users and devices within the customer premises.

Competitive Landscape

Assessing the many competing technologies and vendors entering the home networking market is a daunting task for operators. The most prevalent networking technologies are displayed in the following table. These are organized by the technology and physical wired/wireless interface.

Home Networking Technology by Standard and Physical Interface

Standard / Technology	IEEE 802.3	HPNAv3.1	HPNAv3.1 MoCA	HomePlug A/V	IEEE 802.11x
Physical Interface / Medium	Ethernet (CAT-5)	Phoneline (Twisted -Pair)	Coaxial Cabling	Powerline	Air/Wireless

In the following section, each technology is evaluated against operator criteria and the strengths and potential pitfalls are presented. A brief explanation corresponds to the rating received in order to provide additional insight to the reader. A "consumer-reports" style rating system key is provided below as a quick reference.

● (Excellent) Meets Criteria

⦿ (Good/Average) Somewhat Meets Criteria

❍ (Poor) Does Not Meet Criteria

Ethernet (Cat-5)		
Evaluation Criteria	**Rating**	**Comments**
Capacity / Bandwidth	⊙	100 Mbps physical layer rating. Actual throughput varies and can drop to as low as 10 Mbps under some circumstances.
Total Deployment Cost	❍	Chipsets are inexpensive (<$8 per chipset), but structured wiring requires multiple installers for several hours at the customer premises increasing labor and materials costs.
Full Quality of Service	⊙	Most standard Ethernet implementations are simple CSMA/CD networks which do not have deterministic transmission characteristics.
Ease of Installation	❍	Low penetration rate of existing structured (cat-5) wiring in homes. Requires technicians for several hours at customer premises
Future-Proof	⊙	1000 Mbps (1 Gbps) Chipsets available, but more expensive
Standard-Compliance	●	IEEE Standards-Bases
Coverage Area	❍	Cat-5/6 cabling must be run to each individual location. Changes must be made by operator.
Customer Installable	❍	No customer-installation available
Privacy and Security	●	Operator-installed structured wiring provides a completely closed networking environment.

HPNA v3.1 (Phoneline and Coaxial Cabling)		
Evaluation Criteria	**Rating**	**Comments**
Capacity / Bandwidth	●	320Mbps PHY rate just announced for HPNA v3.1 products.
Total Deployment Cost	●	Integration cost is moderate at <$12 per chipset in volume. Can reuse existing in-home wiring mitigating installation technician time at customer premises. For IPTV deployments, does not require additional RF front-end, reducing overall implementation cost.
Full Quality of Service	●	HPNA v3.1 provides guaranteed delivery, jitter, latency and PER
Ease of Installation	⊙	Reuse of existing coaxial cabling provides ease-of-installation. RJ-11 outlets may not be placed near optimal TV locations.
Future-Proof	●	320Mbps PHY rate should provide adequate headroom for future applications.
Standard-Compliance	●	Standardized by ITU and by Home Phoneline Networking Alliance
Coverage Area	●	HPNA v3.1 over Phoneline does not provide adequate coverage as RJ-11 jacks are generally limited in the home and are not in close proximity to television sets. HPNA v31 over coaxial cabling provides excellent coverage to primary TV locations. HPNA v31 can bridge between Coaxial and Phoneline in order to extend coverage.
Customer Installable	⊙	Standard does not preclude customer installation.
Privacy and Security	●	Coaxial cabling is not prone to interference and cabling can easily be isolated from a neighbor's cable plant through an inexpensive (<$1) filter.

HomePlug A/V		
Evaluation Criteria	**Rating**	**Comments**
Capacity / Bandwidth	⊙	200 Mbps PHY channel rate and 150 Mbps information rate.
Total Deployment Cost	⊙	Chipset costs are <$10 for integration in STB, Gateway, etc. External adapter costs range from $50 - $80 per connection.
Full Quality of Service	⊙	Provides QoS guarantees through TDMA access through guaranteed bandwidth allocation/reservation. However, actual throughput is highly susceptible to home environment and devices running on the same circuit.
Ease of Installation	●	HomePlug local area networks are relatively easy for customers and installation technicians to provision and install. Difficulties can arise when there is interference on the power circuit.
Future-Proof	⊙	Future scaling and bandwidth requirements are forthcoming from the HomePlug Alliance.
Standard-Compliance	●	Standardized by the HomePlug Powerline Alliance. Other broadband powerline associations also promoting standards.
Coverage Area	●	Networking coverage is available at any location where a power outlet is available.
Customer Installable	●	Yes. HomePlug A/V and HomePlug 1.0 Turbo Adapters are available. Some IPTV operators allow customers to install additional IP STBs through use of HomePlug Adapters.
Privacy and Security	●	Provides 128-bit AES security and dynamic change of encryption keys

IEEE 802.11(x) (Wireless Air Interface)		
Evaluation Criteria	**Rating**	**Comments**
Capacity / Bandwidth	⊙	Various 802.11 wireless standards are being targeted. 802.11g offers PHY rates of 54 Mbps. 802.11n products should achieve aggregate throughput rates in the 60 – 100+ Mbps range
Total Deployment Cost	❍	Deployment costs are generally high. Access Points are in the $75 - $150 range. (depending on technology) Wireless chipsets for integration into STBs are moderately priced at <$20 depending on technology deployed.
Full Quality of Service	⊙	QoS is not inherent in the standards. Third party software and smart antenna solutions must be employed to guarantee QoS and eliminate interference from nearby wireless networks.
Ease of Installation	●	Wireless networks deployed by IPTV operators require significantly less time on-site by installers relative to structured Cat-5 rewiring
Future-Proof	⊙	Future air-interface standards will be developed by industry to accommodate high-bandwidth and QoS requirements demanded by the industry.
Standard-Compliance	●	Wireless standards are ratified by the IEEE
Coverage Area	⊙	In theory, wireless provides ubiq uitous coverage. However, coverage areas differ greatly between homes.
Customer Installable	⊙	Standards do not preclude customer installation. Due to complexities and potential coverage area limitations, customer-installation will be extremely limited.
Privacy and Security	⊙	Wireless networks are inherently prone to interference due to the unlicensed 2.4 GHz / 5 GHz bands they operate in. Software solutions and advanced antenna solutions can mitigate potential problems.

MoCA (Coaxial Cabling)		
Evaluation Criteria	**Rating**	**Comments**
Capacity / Bandwidth	●	MoCA chipsets provide up to 270 Mbps up/downstream data rates.
Total Deployment Cost	⊙	Chipsets in the $11 - $13 with targets of <$10 as volumes increase. Uses existing in-home minimizing truck-roll times. RF front end may add additional costs.
Full Quality of Service	●	TDMA scheme / tunable channels provides robust QoS for each video stream
Ease of Installation	●	Coaxial cabling is installed in nearly all US homes. Field tests demonstrate that MoCA achieves more than 100 Mbps net throughput in over 97% of homes.
Future-Proof	●	MoCA generally operates in the 800 – 1500 MHz band providing 4 Gbps of usable bandwidth and headroom for future products.
Standard-Compliance	●	The Multimedia Over Coax Alliance develops and promotes standards.
Coverage Area	●	Coax is generally located in each of the primary entertainment locations in the home.
Customer Installable	⊙	Not precluded by standard. Operators currently plan professional install.
Privacy and Security	●	In-home Coaxial cabling can easily be isolated from a neighbor's cable plant through an inexpensive (<$1) filter. MoCA also specifies packet-level encryption.

The challenging technical and market requirements demand that technologies must meet or exceed the evaluation criteria in order to be successfully deployed. The vast number of worldwide IPTV deployments and unique requirements of each operator ensures that a number of technologies will be deployed in IPTV customer premises equipment. Deployment forecasts by CPE device category and technology are provided below.

Target Platforms for Advanced Networking Integration

In order to distribute IP-based services throughout the home, each customer premises equipment platform must have access to the home network. While the IP Set top Box is a primary target for home networking technology integration, operators are also integrating home networking technologies into Optical Network Terminals (ONT), Residential Gateways / Broadband Home Routers (BHR).

The ONT/ONU (Optical Network Terminal) unit provides the interface between the fiber link connecting the central office equipment to the subscriber's residence. In addition to terminating the PON fiber, the ONT provides industry standard interfaces for the delivery of broadband data, traditional or VOIP (Voice Over Internet Protocol) service, analog or RF video and IPTV (Internet Protocol Television). Like an ONT, the iNID (Intelligent Network Interface Device) can provide an interface between the operator's network and the subscriber residence. The iNID is most often associated with terminating a VDSL2 connection from the central office (CO). The growth that S2 Data forecasts for FTTH and VDSL will be the driving force behind the ONT/iNID forecast. The market for ONT/iNID was 1.6 million units in 2005. This number will nearly triple in 2006 to 4.6 million units. By 2010, the market will reach 11.4 million units on an annual basis. This equates to a CAGR of 90.7% over the forecast period.

The IPTV Set Top Box (STB) is the cornerstone of the customer premise equipment for an IPTV deployment. The STB provides the interface between the customer and the service, and will be the primary driver of a positive user experience. The STB offers the greatest opportunity for integrating a number of features, including DVR, networking, digital media adapter functionality, etc. All of these features will provide an opportunity for the service provider to enhance the experience and generate additional revenue from the IPTV service. As the number of IPTV subscribers grows, so will the number of IPTV STBs. New subscribers will require one or more set top boxes, depending on the number of TVs in the household. This will be especially true, as the advanced networking technologies distribute the IP signal in a digital format, and a STB will be required at each TV to decode this signal for display. In 2005, 1.6 million units were shipped into the market. As more services are being deployed, and the number of subscribers increases, this number will grow dramatically over the forecast period. By 2010 over 21 million units will be shipped worldwide.

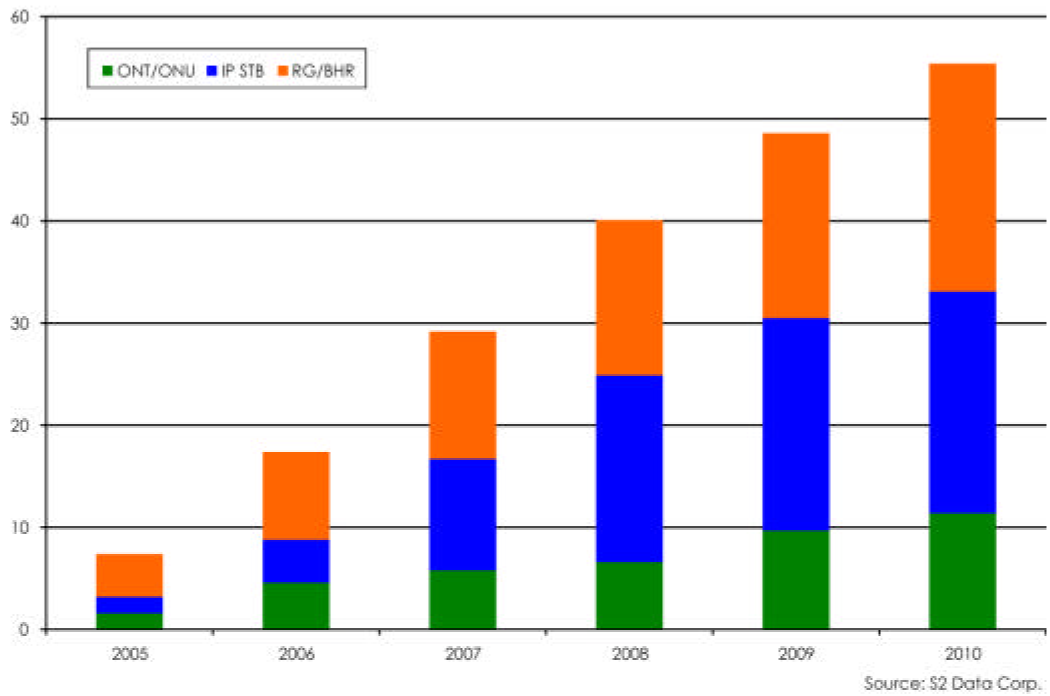
DSL gateway shipments have risen dramatically in the last two years with some gateway manufacturers reporting a doubling of year over year sales. Gateways are rapidly replacing traditional standalone DSL modems, enabling operators to deliver, manage and provision higher value service over the broadband connection often reducing churn and increasing revenues. Most currently shipping gateways integrate wireless LAN technology for providing wireless data networking to PCs throughout the home. However, other technologies such as HPNA, MoCA and HomePlug are finding their way into an emerging generation of residential gateways to provide potentially higher bandwidth and more reliable wireline interfaces. In 2005, 4.2 million residential gateways shipped worldwide. That number will more than double in 2006, and the growth will continue through the forecast period, with more than 22 million residential gateways shipping in 2010.

Forecasts for Advanced Networking Target Platforms (millions of units)

	2005	**2006**	**2007**	**2008**	**2009**	**2010**
ONT/ONU	1.6	4.6	5.8	6.6	9.7	11.4
IP STB	1.6	4.2	10.9	18.3	20.8	21.7
RG/BHR	4.2	8.6	12.5	15.2	18.1	22.3

Source: S2 Data Corp.

Forecasts for Advanced Networking Target Platforms (millions of units)



Networking Port TAM and Technology Breakout Forecasts

Despite best efforts to single-out a predominant technology with which to deploy services, most operators, even within their own customer base do not plan to rely solely on a single technology. A prime example is the Hong Kong PCCW deployment which employs wireless, powerline, CAT-5 and other technologies, depending on a combination of factors encountered at the home they are deploying to. In addition, many operators view a hybrid network approach as the most favorable scenario for partitioning voice, video and data and guaranteeing QoS for each service.

The end result, as the following forecasts illustrate is a patchwork landscape where a number of technologies will compete in numerous configurations. Due to this fact, some customer premise equipment, particularly Residential Gateways, may ship with more than one advanced home networking technology on board, in addition to standard RJ-45 Ethernet ports.

The forecasted number of ports shipped through the forecast period provides an even more accurate and compelling picture of the market opportunity. By 2010, S2 Data expects over 66 million advanced home networking ports will ship in customer premise equipment dedicated to supporting Telco IPTV / Triple-Play deployments. It is critical to understand that not all ports may be used, but will be available on the platforms. A primary example would be a Residential Gateway that has both 802.11g and coaxial-based networking integrated on the platform. Some Telcos may use the integrated 802.11g solution to provide data networking in the home and the integrated coaxial networking port to deliver IPTV streams to the STB.

Over time, S2 Data predicts that the largest increase in ports will come from Residential Gateways which are likely to ship with a combination of wireless networking and another advanced home networking solution such as powerline, coax or phone line solutions, in addition to a standard Ethernet port. Again, standard Ethernet ports are not figured into the forecast in order to draw greater attention to the true market opportunity for advanced home networking ICs. Some IP STBs will ship with multiple AHN ports and this figure increases over time in the forecasts due to integration of at least one or more AHN technologies in the host STB controller chipset expected in the late Q3 2007 timeframe.

Unlike residential gateways and IP STBs, the ONT / iNID is more likely to only have only one type of Advanced Home Networking integrated into the platform. ONT/iNID manufacturers are employing a more modular approach to the platform which will allow operators to integrate a module of their choice, thereby determining the networking technology at the point of installation.

The following table and chart provide a detailed breakout of networking ports by their physical wired or wireless interface. The forecast is divided into Coaxial, Phoneline, Powerline, and Wireless ports. Before evaluating the forecast for each transport medium, it is important to note that one or more technologies may be applicable to a given segment. In the case of Coaxial ports, these may be enabled by MoCA chipsets or other technologies which support bridging to coaxial cable from their native physical medium. Because more than one technology may be applicable to a transport medium, no inference should be made to specific market shares of companies delivering networking ICs.

The forecast in the following table shows Coax-based technologies growing from just over 170,000 units in 2005 to over 18 million ports in 2010. The most significant growth will come from the North American market where pre-installed coaxial wiring is already in place in well over 90% of homes. Significant deployments with coaxial wiring are already in place with many vendors having announced design wins in ONT/iNIDs, IP STBs and Residential Gateways, or as separate adapters. We expect Coax-based technologies to experience modest growth in Europe throughout the forecast period, with more aggressive growth in Asia, most notably from Japan and Korea where coaxial wiring in the home is somewhat more common.

Although not traditionally categorized as an IPTV deployment, Verizon's FiOS service is currently the largest consumer of MoCA coaxial-based networking chipsets. The figures in the forecast below take the Verizon FiOS deployment into account as a Telco TV deployment. Verizon has also signaled plans over time to transition away from the hybrid approach to a more traditional IPTV model. In addition, to Verizon, Coax-based networking has also received a huge boon from AT&T's ongoing deployments of HPNA 3.0 for in-home distribution of the AT&T U-verse services in 11 markets. Although the vast majority of AT&T deployments will employ HPNA over coax, the phoneline networking option will be deployed in some scenarios such as MDUs where Telecommunications companies are precluded from reaching customers over existing coax plant.

Worldwide TAM – Advanced Home Network Ports by Interface Type (millions)

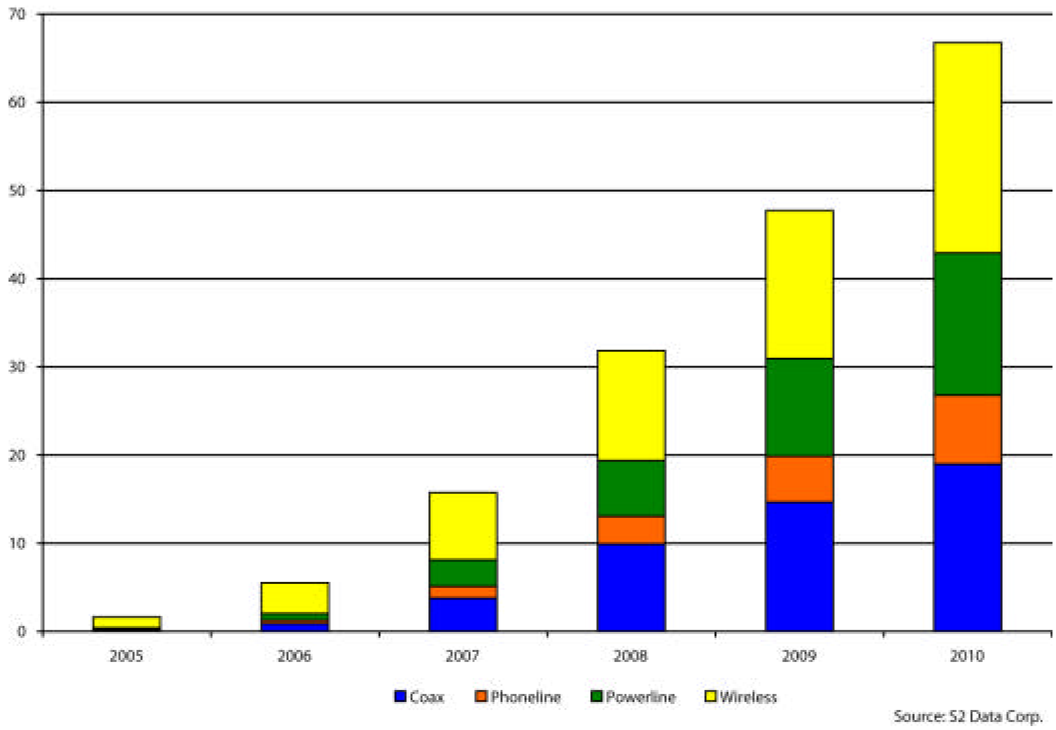
	2005	2006	2007	2008	2009	2010
Coax	0.176	0.882	3.757	9.903	14.648	18.965
Phoneline	0.053	0.383	1.355	3.152	5.215	7.798
Powerline	0.155	0.749	2.992	6.292	11.059	16.124
Wireless	1.246	3.495	7.634	12.486	16.796	23.872

Source: S2 Data Corp.

The 2005 port figure for phoneline networking is relatively low as it has experienced only limited traction in current IPTV deployments, notably in eastern European deployments and some in Asia. As a result of limited deployments, most of the early growth figures are due to growth in phoneline networking support in Residential Gateways shipping as part of Telco Triple-play offerings. Over time Europe and Asia will account for the largest growth in phoneline home networking deployments, and this technology will see a total of nearly 8 million ports shipping in 2010.

Powerline, though often described as the 'dark-horse' in the landscape of home-networking technologies will experience substantial gains over the course of the forecast period surpassing the 16 million port mark in 2010. The vast majority of Powerline ports will ship as part of hybrid networking solutions where powerline is used to extend a coax, phoneline or wireless network to distribute IPTV signals to extended locations. Due to the ease of installation, Powerline networking adapters are often used by Telcos to extend wireless coverage in the home. By nature, Powerline technologies are easily used in a variety of customer-installable scenarios making it attractive for operators who wish to minimize truck-rolls. We expect powerline networking technologies to play a significant role over time, particularly in Residential Gateways deployed in Europe and Asia where powerline is already making significant inroads in some of the largest IPTV deployments.

Worldwide TAM – Advanced Home Network Ports by Interface Type (millions)



The wireless networking figures presented in the forecast shows substantial growth over the forecast period. Wireless networking chipsets will appear in IP STBs and Residential Gateways, as well as Access Points deployed by Telcos. The largest growth in wireless networking ports is attributed to a high level of integration in Residential Gateways which will enable whole-home data networking and broadband access. In some deployments, wireless networking will provide the backbone for distribution of IPTV video streams accounting for growth beyond Residential Gateways with advanced home networking ports. Despite the allure of wireless networking for distribution of video, it has thus far not seen widespread implementation as the primary networking technology of choice despite some design wins at a small number of telecommunications operators.

Summary

As telecommunications companies continue to roll out IPTV as part of their Triple-Play offerings, deploying the right advanced home networking technologies is becoming an increasingly vital part of each operator’s strategy. When implemented correctly, with an eye towards future service sets and applications, operators have an opportunity to protect their investments by deploying home networking technologies that will allow expansion of services in the future.